Lentil in Saskatchewan

Revised: July 2006

Introduction

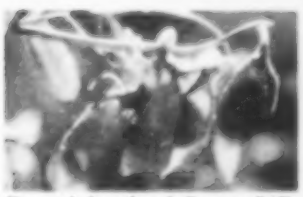


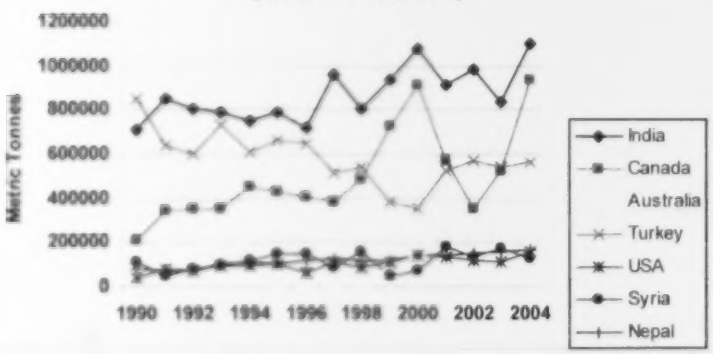
Figure 1. Lentil pods Source: SAF

Lentil (*Lens culinaris L.*) was first grown in southwest Asia about 7,000 B.C. It is best adapted to the cooler temperate zones of the world, or the winter season in Mediterranean climates. Split lentil (dhal) is an important source of dietary protein in the Mediterranean and south Asian regions.

Lentil is a very important pulse crop in western Canada. It is grown to improve economic returns to producers, diversify and lengthen crop rotations, and reduce the requirement for nitrogen fertilizer. Lentil, a member of the legume family, Leguminosae, can supply a significant part of its nitrogen requirement by fixing nitrogen from the air when inoculated with the appropriate rhizobial inoculant.

Total world lentil production ranged from 2.8 – 3.8 million tonnes from 1997-2004. Major lentil producing countries include India, Canada, Turkey, Syria, Australia, Nepal and the United States (Figure 2). Canada is the leading lentil exporting nation, while India is the leading lentil consuming and producing nation.

Figure 2. Leading Lentil Producing Countries (Source: FAO, 2004)



Commercial production of lentil in western Canada began in 1970, when approximately 600 hectares (ha) were grown. Production has increased in Saskatchewan to 850,000 ha (2.1 million ac.) in 2005.

The 10-year average yield in Saskatchewan is 1,180 kg/ha (1,050 lb./ac.), and the bushel weight of lentil is 60 pounds.

The Saskatchewan Agriculture and Food (SAF) publication, *Specialty Crop Report*, contains more statistical information on lentil.

Lentil seed size is classified in two types: Chilean/large-seeded (greater than 50 grams per 1000 seeds) and Persian/small-seeded (40 grams or less per 1000 seeds). The two main market classes are green and red. Green lentil is usually marketed as whole seed, while red lentil is

marketed as whole seed or in de-hulled and split form. The majority of world lentil production and trade is in red lentil. Seed coat colour can vary from clear to light green to deep purple, mottled, grey, brown or black. Cotyledon (seed leaf) colour is yellow, red or green. The predominant lentil grown in western Canada is the large-seeded green type, such as the variety CDC Sovereign.

Plant Description

Lentil plants are typically short, compared to cereal crops, ranging from 20-75 cm (8-30 in.) in height. The first two nodes on the stem develop below, or at the soil surface, and are known as scale nodes (Figure 3). Injury to young lentil seedlings by late spring frost, heat canker or wind damage may cause the plant to initiate regrowth from a scale node below the soil surface. The third node on the stem is the usual site of the first leaf development. Lentil seedlings can produce a new node every four-five days under good growing conditions. Just prior to flowering, new leaves will develop a short tendril at the leaf tip.

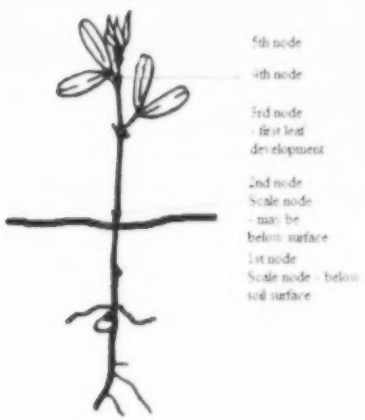


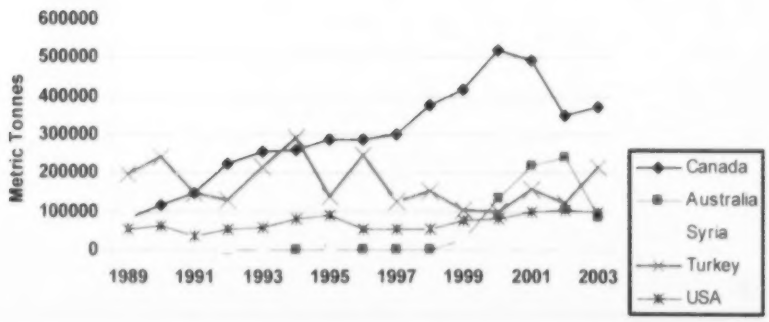
Figure 3. Lentil seedling

Leaves are about five centimetres (2 in.) long with nine-15 leaflets. Lentil plants have an indeterminate growth habit, so they will continue to flower until there is some form of stress, such as lack of moisture, nutrient deficiency, or high temperature. Flowers are self-pollinated. Flower stalks produce one to three flowers which develop pods. Pods (Figure 1) are less than 2.5 cm (1 in.) in length and contain one or two seeds. Most of the seed is produced by the aerial branches which form from the uppermost nodes on the main stem just below the first flowering node.

Market Opportunities

Lentil is used mainly for human consumption as a source of protein and carbohydrate in soups, stews and vegetarian dishes. Most lentil is consumed in the region of production, except for Turkey, Australia and North America. Canada is the largest exporter of green lentil in the world (Figure 4). The United States and Turkey also export green lentil. Turkey remains the largest red lentil exporter, while Canada, Syria, and Australia supply the remainder of the world's red lentil export markets.

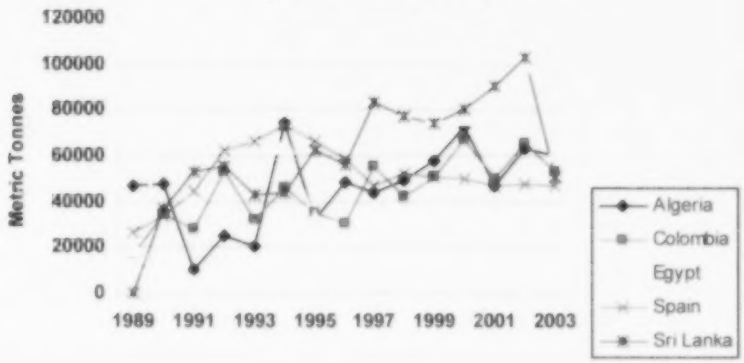
Figure 4. Leading Lentil Exporting Countries (Source: FAO, 2004)



The major importing countries are Spain, Colombia, Egypt, Algeria, and Sri Lanka (Figure 5), with France, Pakistan, Bangladesh

and India also importing significant quantities. Canada has been successful in exporting the large-seeded green lentil to western Europe and Colombia, and the small-seeded green and red lentil to countries in the Mediterranean region. A significant growth opportunity exists for Canada in the red cotyledon market as Turkey's production and exports have trended lower. In some years, Turkey is an important importer of red lentil from Canada. Recently, secondary processing capacity within Canada has expanded providing additional export of already-split red lentil to world markets.

Figure 5. Leading Lentil Importing Countries
(Source: FAO, 2004)



Nutritional Characteristics

Table 1. Nutritional components in lentil seed and straw for livestock rations (Source: Prairie Feed Resource Centre)

	Seed	Straw
Protein (%)	22	nil
TDN (%)	nil	44-46
D.E/ (swine) (Kcal/kg)	3,250	nil
Calcium (%)	0.1	0.65
Phosphorus (%)	0.39	0.20
Crude fibre (%)	nil	4.80
Fat (E.E.) (%)	nil	1.50
Lysine (%)	nil	1.60
Methionine+cystine (%)	nil	0.48

(average basis - individual samples are required for more accurate analysis)

Nutritional information for human consumption is available from the Saskatchewan Pulse Growers website: www.saskpulse.com

Adaptation

Lentil is a cool season crop with a relatively shallow root system (0.6 m or 2 ft.) and is moderately resistant to high temperature and drought. Lentil has an indeterminate growth habit, and often will continue to flower as long as growing conditions remain favourable for vegetative growth. Therefore, a moisture or nitrogen stress is required to encourage seed set and hasten maturity. Lentil does best in soil with pH levels of 6.0 - 8.0 and will not tolerate water-logging, flooding, or soils with high salinity.

In Saskatchewan, lentil is best adapted to the Brown and Dark Brown soil zones, but can be grown successfully in the Thin Black soil zone in years without excessive moisture. In the Brown soil zone, lentil performance is best on fallow in medium to fine textured soils, or on stubble using direct seeding techniques. In the Dark Brown, moist Dark Brown, and Thin Black soil zones, lentil grown on stubble tends to receive a stress needed to reduce the time to maturity, prevent excessive vegetative growth, and reduce the risk of damage from early fall frost. To date, most lentil production in Saskatchewan has been of the large green market class. There is opportunity to expand lentil production into the moist Dark Brown and Thin Black soil zones by increasing red and small green production. These more determinate red and small green varieties are better suited to the cooler moist lentil growing areas of the province. Research is ongoing to determine the best varieties and agronomic practises for lentil production in these areas.

Rotational Considerations

Lentil production is most successful when grown in rotation with cereals, such as spring, or durum wheat. Crop rotation research conducted by Agriculture and Agri-Food Canada (AAFC), Swift Current, shows yields of cereal crops grown on stubble were best following lentil or pea crops. Lentil rooting depth was found to be about 0.6 m (2 ft.). This allows the following wheat crop, with a rooting depth to 1.8 m (6 ft.), to extract water from a greater depth and produce higher yield and protein.

Lentil is susceptible to ascochyta blight and anthracnose (see Disease Control), and careful consideration must be given to crop rotation to reduce the risk of these diseases. In areas

where ascochyta blight is a problem, avoid lentil production more frequent than one in three years in the same field. In areas where anthracnose is a problem, avoid seeding lentil more often than one in four years in the same field, and avoid seeding lentil in fields adjacent to lentil stubble, as anthracnose is easily transferred on wind-blown dust and residue. Lentil seedling diseases, such as root rots and seedling blights, are more common in fields where pulse crops have been grown more frequently.

Sclerotinia stem rot may be a problem if lentil follows other susceptible broadleaf crops, such as canola, sunflower, mustard or pea. Volunteer flax, canola, or mustard may be difficult to control in lentil. Volunteer cereals, such as barley or durum wheat, are difficult to clean from lentil seed and should be controlled in the field.

Experienced lentil growers refrain from growing red and green cotyledon lentil in rotation in the same field for at least four years to avoid class contamination. As is the case with mustard and canola production, it may be advantageous to never grow red and green lentil in the same field, but designate fields for one colour only.

Fallow fields with high levels of available nitrogen and moisture may produce excessive vegetative growth, at the expense of seed production, especially in late-maturing varieties. Research conducted at AAFC Swift Current indicates that lentil seedlings benefit from the protection of standing cereal stubble, as the seedlings are less prone to damage by wind or heat. However, lentil seedlings emerging through poorly spread crop residue can be more susceptible to late spring frost. Lentil does not provide much crop residue. For more information about reducing erosion in crop rotations that include lentil, see the SAF publication, *Securing Low Erosion Risks after Growing Pulses and Oilseeds*.

Lentil is a very poor competitor to weeds, so selection of a mostly weed-free field is essential, as few herbicides are registered for use. Perennial weeds, such as Canada thistle and sow thistle, should be controlled in the years prior to lentil production. Lentil is susceptible to the soil residues of some herbicides used in previous years. It is important to maintain herbicide records each year and to avoid seeding lentil in fields with the following herbicide history: TORDON - within the past five years; ALLY, ESCORT – within the past four years; EVEREST, K2 – within the past three years; ASSERT, SUNDANCE –within the past two seasons; MUSTER, FLAX MAX ULTRA, UNITY, PURSUIT (non Clearfield varieties), ODYSSEY (non Clearfield varieties), LONTREL, CURTAIL, SPECTRUM, FRONTLINE, FRONTLINE 2,4-D, ACCENT, PRESTIGE, PREVAIL, BANVEL II (high summerfallow rate) – in the previous season; RUSTLER, BANVEL II – following late fall or spring application, 2,4-D – following spring application. The SAF publication, *Guide to Crop Protection*, contains more information about herbicides and their soil residual properties.

Varieties

Green varieties

The majority of lentil varieties grown in Canada have green seed coats and yellow cotyledons (seed leaves). Green lentil is divided into three market classes in Canada - large green, medium green, and small green. The release of the large green variety Laird (Table 2) by the Crop Development Centre in Saskatoon in 1980 was the single most important factor contributing to the rapid expansion of the lentil industry in Canada. CDC GLAMIS, CDC PLATO, CDC GRANDORA, and CDC SOVEREIGN are new ascochyta blight resistant (see Disease Control) large green lentil varieties. Most of the large green varieties require early

seeding because they are relatively late maturing and indeterminate. They produce tall plants which can be prone to lodging, and are susceptible to botrytis (grey mould) infestations in high rainfall areas. CDC Sedley is a new large green lentil with moderate ascochyta blight resistance and earlier maturity, compared to other large green varieties. CDC Richlea is a medium green lentil similar in size and colour to the Chilean lentil grown in United States. It is high yielding and susceptible to ascochyta blight. CDC Vantage and CDC Meteor are high yielding, ascochyta resistant, medium green varieties with similar seed and plant characteristics as CDC Richlea.

Eston is a small green lentil that is short and early maturing. Eston is susceptible to ascochyta blight. CDC Milestone is a high yielding, ascochyta blight resistant, small green variety. CDC Viceroy is high yielding and resistant to ascochyta blight and Race 1 anthracnose. All other green lentil varieties grown in Canada are susceptible to anthracnose (see Disease Control).

Red varieties

Canada has recently become an important producer and exporter of red lentil. Red lentil varieties typically have brown to pale green seed coats with red cotyledons. Red lentil accounts for more than half the world trade of the crop and is sold in either whole seed or split form. Processing facilities capable of de-hulling and splitting red lentil suitable for the world market have been built in Saskatchewan.

Crimson has a brown seed coat and is susceptible to ascochyta blight, anthracnose (Table 2) and lodging. It was developed in the United States at Washington State University. CDC Robin and CDC Rosetown have a brown seed coat and are resistant to both ascochyta blight and Race 1 anthracnose, and have a smaller, more rounded seed. CDC Blaze has a grey seed coat, is resistant to ascochyta blight, and has similar seed traits with improved yield and lodging tolerance compared to Crimson. CDC Redberry and CDC Rouleau have grey seed coats and are resistant to both ascochyta blight and Race 1 anthracnose. CDC Redberry has a larger seed size compared to other red lentil varieties. CDC Impact and CDC Imperial are the first two Clearfield lentil varieties released in Canada. CDC Impact has the same yield, disease and quality attributes as CDC Blaze, but is tolerant to the Clearfield herbicides. CDC Imperial has the same yield, disease and quality attributes as CDC Robin, but is tolerant to the Clearfield herbicides.

Other varieties

Small quantities of French green or dark speckled market class lentil varieties, such as CDC LeMay are produced in Saskatchewan. Varieties such as CDC Gold, Red Chief, and Indianhead, called Beluga in the United States (Table 2) are produced in small volumes in western Canada and are sold into niche (specialty) markets. The SAF publication, *Varieties of Grain Crops* includes annually updated lentil variety information.

Table 2. Lentil Varieties (revised: December 2005)

Variety	Market Class	Seed coat Colour	Seed Size (g/1000 seeds)	Seeding Rate (lbs/a)	Height (cm)	Days to flower	Maturity Rating	Ascochyta Blight Resistance	Anthracnose Race 1 Resistance	Yield (% of Laird) Brown and DK Brown Soil
Laird	large green	green	67	80-90	41	53	very late	very poor	very poor	100
CDC Plato	large green	green	62	80-90	38	52	med-late	good	poor	129
CDC Sovereign	large green	green	66	80-90	40	52	late	good	poor	119
CDC Grandora	large green	green	69	80-90	40	53	very late	good	very poor	107
CDC Sedley	large green	green	68	80-90	39	51	medium	fair	very poor	115
CDC Glamis	large green	green	60	80-90	39	54	very late	good	very poor	110
Eston	small green	green	33	40-45	30	48	early	very poor	very poor	113
CDC Milestone	small green	green	37	40-45	31	49	early	good	very poor	134
CDC Viceroy	small green	green	33	40-45	34	49	early	good	good	137
CDC Richlea	medium green	green	51	53-62	35	50	medium	very poor	very poor	130
CDC Vantage	medium green	green	52	53-62	33	49	medium	good	very poor	128
CDC Meteor	medium green	green	59	70-75	39	58	medium	good	very poor	142
CDC Redwing	red	green	38	40-45	30	50	early	good	very poor	118
Crimson	red	brown	35	50-55	29	49	early	very poor	very poor	112
CDC Blaze	red	brown	34	40-45	30	47	early	good	poor	113
CDC Impact***	red	brown	34	40-45	30	47	early	good	poor	**
CDC Robin	red	brown	30	35-40	30	49	early	good	good	118
CDC Imperial***	red	brown	30	35-40	30	49	early	good	good	**
CDC Redcap	red	green	35	40-45	30	49	early	good	fair	119
CDC Redberry	red	brown	42	45-50	34	50	early	good	good	128
CDC Rouleau	red	brown	37	40-45	33	52	medium	good	good	133
CDC Rosetown	red	brown	31	35-40	31	52	early	good	good	129
Red Chief*	red	red	54	55-60	42	51	medium	very poor	very poor	**
common	French green	green	31	40-45	32	49	early	poor	very poor	122
CDC Royale	French green	green	35	40-45	33	49	medium	very poor	very poor	**
CDC LeMay	French green	green	32	40-45	35	48	early	fair	very poor	122
Indianhead* (Beluga)	green manure	black	30	30-40	40	57	late	good	very poor	**
CDC Matador	Spanish brown	green	35	35-40	35	50	medium	good	very poor	**
CDC Gold*	Zero-tannin	yellow	45	55-60	38	52	medium	very poor	very poor	**

*unregistered variety
**limited data
*** Clearfield tolerant variety

Inoculation

Lentil inoculated with the proper Rhizobium strain is able to fix a significant portion of its nitrogen requirement from air in the soil. For this to occur, the seed or the soil surrounding the seed must be inoculated or treated with an inoculant formulated for lentil that contains compatible rhizobial bacteria. The rhizobia enter the root hairs of the plant and induce nodule formation. The plant provides energy and nutrients for the bacteria living inside the nodules and the rhizobia, in return, convert atmospheric nitrogen to a form that can be used by the plant. The maximum benefit from nitrogen fixation is derived if the supply of available soil nitrogen is low and the soil moisture and temperature levels are good at the time of seeding. Rhizobium bacteria may die if they are exposed to stresses such as high temperature, drying winds or direct sunlight. Therefore, both inoculant products and inoculated seed should be handled with care and every effort must be made to plant the inoculated seed into moist soil as soon as possible after inoculation. Rhizobium bacteria on inoculated seed will soon die if the seed is placed into a dry seedbed.

Rhizobium bacteria may be sensitive to direct contact with granular fertilizer, so do not tank mix fertilizer with inoculated seed. Inoculants are also sensitive to some seed-applied fungicides (see Disease Control). When using a combination of fungicide and inoculant, apply the fungicide to the seed first, allow it to dry and then apply the inoculant immediately prior to seeding. Granular inoculants are less sensitive to seed-applied fungicides than other formulations because the granular product does not have direct contact with the seed treatment. The SAF publication, *Inoculation of Pulse Crops*, provides more detailed information on the use of nitrogen-fixing inoculants.

Seeding

The use of high quality seed is extremely important for successful lentil production. It is important to have lentil seed tested by a seed-testing laboratory for germination, purity and seed-borne disease. Seed-borne diseases, such as ascochyta blight and botrytis can reduce seedling vigour and lead to yield and quality losses. (See the Disease Control section for more information on seed-borne diseases of lentil.)

Lentil seed is susceptible to mechanical damage during harvest, handling or seeding operations. Dry seed (less than 14 per cent moisture) is brittle and can easily crack or chip leading to reduced germination. Moisturizing the seed with water before seeding can reduce mechanical injury. The Prairie Agricultural Machinery Institute (PAMI) has produced a factsheet, *Moisturizing Pulses to Reduce Damage* (See Additional Information).

Firm, weed-free seedbeds on well-drained soils are best for lentil production. Stony fields should be avoided or rolled after seeding to bury loose stones and smooth soil ridges that may present problems at harvest. The recommended seeding depth for lentil is 3-8 cm (1-3 in.). See the Weed Control section for seeding depth considerations when using metribuzin herbicide.

Table 2 provides the appropriate seeding rate for each lentil variety. The desired plant population for lentil is 130/m^2 (12/$ft.^2$). Crop stands of this density provide better competition against weeds and will result in higher yields. Crop stands of greater density may increase the risk of foliar diseases, especially in wetter areas. Wider row spacing can be used in high moisture regions to reduce the risk of a thick crop canopy leading to poor pod set, foliar disease development, and lodging.

The optimum seeding rate for each seed lot depends on its seed size. For example, the large green lentil variety CDC Sovereign has an average seed size of 66g/1000 seeds. The following formula should be used to determine the intended target seeding rate for individual seed lots.

$$\text{Seeding rate (lb./ac.)} = \frac{(\text{target \# plants/ft.}^2 \times \text{1000 seed wt. g}) \times 10}{\text{\% field emergence or survival}}$$

$$\text{Example: CDC Sovereign} \quad \frac{(12 \text{ plants/ft.}^2 \times 66 \text{ g}) \times 10}{95 \text{ \% survival}} = 83 \text{ lb./ac. seeding rate}$$

The seeding date should be as early as possible, provided the average soil temperature at depth of seeding is greater than 5°C and the soil is not excessively wet. Lentil seedlings can withstand some late spring frost. Even if the frost is severe enough to kill the main shoot, the lentil plant can regrow from one of the scale nodes at or below the soil surface. Early seeding can help avoid flower blast caused by high temperatures during flowering. Early seeding may also increase the height and size of the plant at time of first bloom, allowing the lower most pods to develop further above ground to ease harvest.

Fertilization

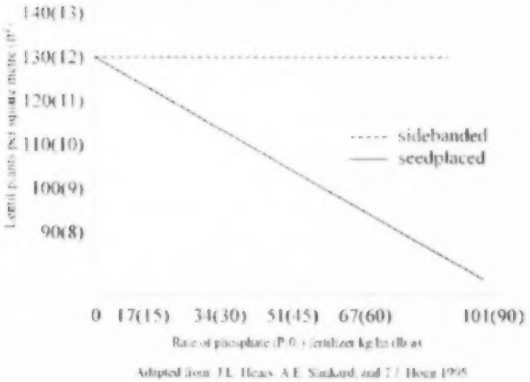
A properly conducted soil test can produce excellent guidelines for lentil fertility needs. Generally, nitrogen fertilizer application is not required if nitrogen fixation is optimized. When properly inoculated with the appropriate rhizobia inoculant, lentil can derive 70 per cent or more of its nitrogen requirement through fixation in good growing conditions. The remaining nitrogen comes from what is available in the soil at seeding, plus nitrogen released from the soil during the growing season.

Nodule formation and subsequent nitrogen fixation are very sensitive to external nitrogen sources, including fertilizers and available soil nitrogen. As the supply of nitrogen from soil and fertilizer increases, the amount of nitrogen fixed by the plant decreases. Low levels of available nitrogen may have little impact on nodulation and nitrogen fixation, however, when the combined levels of soil and fertilizer nitrogen reach 28-40 kg/ha (25-35 lbs./ac.), any additional nitrogen will reduce nodulation and nitrogen fixation. Combined levels of soil and fertilizer nitrogen greater than 55 kg/ha (50 lbs./ac.) can dramatically delay nodulation and reduce or eliminate nitrogen fixation. It can take up to three to four weeks after planting before nodules are fully functioning. In soils with nitrogen levels less than 11 kg/ha (10 lbs./ac.), early plant growth may be poor and plants may appear yellow due to a nitrogen deficiency. This early nitrogen deficiency can be corrected by adding low levels of starter-nitrogen at seeding. Similarly, if nitrogen fixation is not optimized due to unfavourable growing conditions (e.g., relatively dry seedbed), lentil may benefit from low rates of starter nitrogen in some years. If the available soil nitrogen level is very low (less than 17 kg/ha or less than 15 lb./ac.) at planting, a small amount (20 kg/ha or 18 lb./ac.) of starter-nitrogen fertilizer may benefit the crop in some years. Although high levels of starter nitrogen may appear to help the crop overcome a nitrogen deficiency during early crop growth stages, final seed yield may not increase. When used in a fertilizer program, side banded or seed placed monoammonium phosphate (example 12-51-0) provides small amounts of starter-nitrogen needed for early plant growth and, depending on the soil

test, may provide all the starter-nitrogen required. The SAF publication, *Inoculation of Pulse Crops*, includes information on actions to take if the crop fails to fix nitrogen through inoculation.

Lentil has a relatively high requirement for phosphorus to promote the development of extensive root systems and vigorous seedlings. Encouraging vigorous root growth is an important step in promoting good nodule development. Phosphorus also plays an important role in the nitrogen-fixing process. Lentil grown on soils testing low in available phosphorus may respond to phosphate (P_2O_5) fertilizer. As with cereals however, dramatic yield responses are not always achieved with P_2O_5 fertilizers. Even if seed yield increases are not achieved every year, a lentil crop may benefit from improved frost, disease, and drought tolerance as a result of phosphorus application. The maximum safe rate of actual phosphate applied with the seed is 22 kg P_2O_5/ha (20 lbs./ac.) in a 2.5 cm (1 in.) spread and 15-18 cm (6-7 in.) row spacing under good to excellent moisture conditions. Rates of seed-placed fertilizer must be reduced if the seedbed has less than ideal moisture conditions. Higher rates of P_2O_5 fertilizer placed with the seed can damage the emerging seedlings and reduce the stand. If higher P_2O_5 rates are required, banding the fertilizer away from the seed (sideband or mid row band) is recommended. Research conducted over a three-year period indicated that increasing rates of seed-placed monoammonium phosphate (11-55-0) resulted in reduced stands of lentil, compared to side-banded P_2O_5 application (Figure 6). In this study, even low rates of P_2O_5 fertilizer reduced the stand, but the benefit due to increased seed yield outweighed the loss due to stand reduction. It is important to recognize that lentil is a poor weed competitor, so stand reduction can lead to serious yield reduction.

Figure 6. Effect of phosphate fertilizer rate on plant stand of lentil



Adapted from J.L. Heaney, A.E. Slinkard, and T.J. Hogan 1995

Some soils in western Canada are testing deficient in sulphur. A 30 bu./ac. lentil crop requires about the same amount of sulphur as a 40 bu./ac. wheat crop; approximately 9-11 kg/ha (8-10 lbs./ac.). Soils testing low in available sulphur should have this deficiency corrected by side banding, mid row banding or broadcasting ammonium sulphate, which contains sulphur in a plant available form. The SAF publication, *Sulphur Fertilization in Crop Production*, contains additional details and options for correcting sulphur deficiencies.

Micronutrient deficiencies in lentil production have not been identified. If a micronutrient deficiency is suspected, consult an agronomist to help identify the problem. It is

advisable to analyze soil and plant samples within the suspect area and compare the analysis to soil and plant samples collected from a non-affected area of the same field. If the analysis confirms a micronutrient deficiency at a relatively early growth stage, a foliar application of the appropriate micronutrient fertilizer can correct the problem. The SAF publication, *Guidelines for Safe Rates of Fertilizer Applied With the Seed*, provides more information about fertilization of lentil.

Land Rolling

Lentil fields should be rolled to provide a smooth and level surface for harvest. Land rolling can be done before the crop emerges, but this practice can lead to increased soil erosion if the soil surface is dry. Research indicates that land rolling after crop emergence can be successfully completed up to the 5-7 node stage, without significant yield loss. Land rolling past this stage can damage plants, increase the spread of foliar diseases, and reduce yield. Best results are obtained if rolling is done when plants are slightly wilted and the soil surface is dry. Rolling should not be done on wet soils or when the crop is damp or stressed by extreme heat, frost, or herbicide application. For more information on land rolling pulse crops, consult the Alberta Agriculture, Food and Rural Development (AAFRD) publication, *Land Rolling Guidelines for Pulse Crops in Western Canada*.

Weed Control

Lentil is a poor competitor against weeds. Good weed control in lentil requires a long-term strategy involving the entire crop rotation. It is very important to control perennial weeds, such as Canada thistle, sow thistle or quack grass in the years prior to seeding lentil. Volunteer canola, mustard, and flax are difficult to control in lentil. Volunteer wheat and barley are difficult to clean from small-seeded lentil and should be controlled in the field. Weeds that germinate late in the season, such as Russian thistle, kochia and wild tomato, cause severe competition to the crop, interfere with harvesting and increase dockage, staining and moisture levels in the harvested seed.

Early seeding is important to allow the crop to better compete with weeds. Research completed at AAFC Scott showed that post-emergent harrowing with a tine harrow can be used to control weed seedlings when the crop is very short (less than 10 cm or 4 in.), provided that the foliage is dry and the operation is done on a warm, sunny day. An increased lentil seeding rate should be used to offset the plant losses during harrowing.

Lentil is susceptible to the soil residues of some herbicides used in previous years (see Rotational Considerations). Lentil is sensitive to herbicide drift. Drift from broadleaf weed herbicides such as REFINE EXTRA, LONTREL, ALLY, MCPA, 2,4-D, or products containing dicamba such as BANVEL, DYVEL and TARGET, and others, can slow crop growth and reduce yield. Sprayer tanks should be thoroughly cleaned before applying any crop protection product on lentil, and producers should inform their neighbours about the location of their lentil crop.

During periods of crop stress (heat, drought, frost, or after land rolling) the ability of the lentil crop to tolerate herbicide application may be reduced. Crop injury can be reduced by waiting approximately four days after the crop stress before applying the herbicide, by maintaining water volumes at label recommendations, and by applying the product during the evening.

A late fall application of a phenoxy herbicide such as 2,4-D or MCPA can be used at rates of 280g ai/ha or less to control winter annual broadleaf weeds in fields planned for lentil production. Spring applications or applications that include dicamba should be avoided to prevent possible crop injury. A pre-emergence burn-off treatment of glyphosate can be used in lentil to control weeds before the crop emerges.
The following herbicides are registered for grassy weed control in lentil: ASSURE II, EDGE, FUSION, POAST ULTRA, clethodim (SELECT, CENTURION), trifluralin (TREFLAN, RIVAL), VENTURE, and ODYSSEY (Clearfield lentil varieties only). The following herbicides are registered for broadleaf weed control in lentil: EDGE, SENCOR, trifluralin (TREFLAN, RIVAL) and ODYSSEY (Clearfield lentil varieties only). SENCOR should be applied early post-emergence. Best performance is achieved when lentil plants are at the 2-5 node stage and the weeds are small. A split application of SENCOR is registered which includes a two-thirds rate followed in seven to 10 days with an additional application of one-half rate if another flush of weeds has emerged. SENCOR can move in the soil after heavy rainfall, so if the use of this product is anticipated, lentil must be planted at least 5 cm (2 in.) deep to prevent injury to seedlings. Do not use SENCOR in soils with less than 4 per cent organic matter. EDGE and trifluralin (RIVAL, TREFLAN) are registered only for fall application. A spring application, especially in lighter soils, can cause seedling injury and may lead to increased incidence of seedling diseases such as rhizoctonia wire stem (see Disease Control).

Glyphosate is registered for pre-harvest weed control in lentil. This application is used to control perennial weeds, such as Canada thistle, sow thistle and quack grass in-crop before harvest begins. Do not use seed from crops treated with a pre-harvest application of glyphosate, as abnormal germination and seedling development will likely occur. Always read and follow label recommendations when using crop protection products. The SAF publication, *Guide to Crop Protection*, provides more information on the use of herbicides and on lentil seedling growth stages.

Disease Control

Seedling blight and root rot are soil-borne diseases that can infect lentil seedlings. These include **rhizoctonia** wire stem, **pythium** damping off, **fusarium** root rot and **botrytis** grey mold. These disease pathogens are present in all Saskatchewan agricultural soils, and can infect and kill individual seedlings from germination to the early flowering stage. Lesions develop at the base of the stem, causing discolouration and constriction of the stem. Diseased plants turn yellow and die. Usually, only scattered plants are infected, so these diseases rarely cause economic loss. Seedling stress or damage due to environmental or herbicide injury can lead to an increase in the incidence of seedling blight, especially wire stem. Crop rotations that include cereal and oilseed crops can reduce the build up of soil-borne pathogens specific to lentil. However, rotation with cereals will not decrease fusarium root rot, as cereals are also hosts of this pathogen.

A seed test can determine if lentil seed is infected with a seed-borne disease, such as **ascochyta** blight, **botrytis** and **anthracnose**. CROWN, APRON MAXX RTA, MAXIM 480FS and VITAFLO 280 seed treatment fungicides are registered for the control of some seedling blights and seed rots of lentil. If a seed treatment fungicide is used, it

should be applied to the seed first, and allowed to dry before applying a nitrogen-fixing inoculant.

Heat canker, which occurs when young lentil seedlings are exposed to hot soil surface temperatures, can easily be confused with seedling blight. With seedling blight, the base of the stem becomes pinched and the seedling turns yellow and dies. With heat canker, the pinched stem usually remains white, and often new shoots are started from the scale nodes.

Ascochyta blight is a serious foliar disease of lentil in western Canada. It can be seed-borne or residue-borne. Lesions form on leaves, stems, pods and seed. Lesions appear as tan or grey spots with dark margins, and often have tiny black fruiting bodies in the centre. This disease is most damaging to maturing pods and seeds if prolonged wet weather occurs during July and August. Severely infected seed lots may not be marketable or will be downgraded severely due to discolouration. Several lentil varieties have resistance to ascochyta blight (Table 2). Producers are advised to have their seed tested for seed-borne ascochyta blight at an accredited seed test laboratory. CROWN and APRON MAXX RTA seed treatment are registered for the control of seed-borne ascochyta blight in lentil and should be considered if test results indicate an infection level above five per cent in the Brown and Dark Brown soil zones. If production is in the Black soil zone, seed with zero per cent ascochyta infection should be used. If test results indicate an ascochyta infection level above 10 per cent, new seed should be obtained.

CROWN or APRON MAXX RTA should be applied to the seed before the application of inoculant. Ascochyta blight inoculum also over-winters on lentil residue, so producers should not plant lentil on lentil stubble. The SAF publication, *Ascochyta Blight of Pulse Crops*, contains more information on this disease.

Anthracnose is a foliar and stem disease found in most lentil producing areas in western Canada. Research has identified two races of anthracnose. A few lentil varieties have been introduced with resistance to Race 1 (Ct1), but no varieties are resistant to Race Ct0. The anthracnose fungus causes grey to cream lesions on leaves and stems. Lower leaflets turn yellow and brown, and drop to the soil surface. The lower stems become cankered by the disease and lose all their leaflets. Brown spots develop that can enlarge and girdle the stem, and the plants die prematurely. Diseased patches in the crop can expand rapidly and appear as yellowed or grey patches within an otherwise green field. The disease is favoured by warm, moist weather and commonly kills the infected lentil plant before seed is produced. Anthracnose can be spread on wind-borne residue and dust during harvest, and can be residue-borne in fields for a number of years. There is no data to show that the disease is transferred from the seed to the lentil seedling. However, producers should attempt to use seed with low infection levels, as there are no seed treatment fungicides effective at controlling seed-borne anthracnose. Extend crop rotations to avoid planting lentil in the same field for at least four years.

BRAVO 500 foliar fungicide is registered for control of ascochyta blight and anthracnose in lentil. It should be applied at the early flowering stage to protect healthy plant material if disease inoculum is present in the field and weather conditions favour the

disease. Up to three applications may be required if conditions favouring the disease persist.

DITHANE foliar fungicide is registered for the control of ascochyta blight and anthracnose in lentil. The first application should be made when bud formation is evident. Up to three applications may be required if conditions favouring the disease persist. In research trials, DITHANE was found to be less effective compared to other fungicides when disease pressure was high.

HEADLINE EC foliar fungicide is registered for control of ascochyta blight and anthracnose in lentil. It should be applied at the early flowering stage to protect healthy plant material if disease inoculum is present in the field, and weather conditions favour the disease.

QUADRIS foliar fungicide is registered for the control of ascochyta blight and anthracnose on lentil. LANCE foliar fungicide is registered for the control of ascochyta blight, sclerotinia stem rot, and botrytis grey mould on lentil.

HEADLINE EC and QUADRIS are members of the strobilurin group of fungicides. Development of resistance of several fungal pathogens to this group of fungicides has been reported in Europe, and is of great concern. No more than two applications per year of any strobilurin fungicide should be made to the same field, as disease resistance could develop. The continuous use of strobilurin fungicides without fungicide rotation greatly increases the threat of disease resistance.

Botrytis grey mould causes stem and pod rot during the flowering and seed filling stages and can cause economic losses. Soil-borne inoculum is present in all fields, but this disease is typically only a problem in heavy vegetative stands that have lodged in wet, cool summer weather. Leaves wilt and drop off, pods fail to fill, and infected areas turn grey to brown. Clouds of grey spores are dispersed into the air as infected areas are harvested. Producers are cautioned to use dust masks to prevent breathing difficulties. LANCE foliar fungicide is registered for the control of the foliar blight caused by botrytis grey mould.

Sclerotinia white mould may occasionally occur in maturing lentil crops under high moisture conditions that promote vegetative growth and lodging, and can cause economic losses. Lentil crops are at increased risk to sclerotinia infection, if grown in rotation with other susceptible crops, such as canola, pea or sunflower. LANCE foliar fungicide is registered for the control of sclerotinia stem rot on lentil. Research completed at the University of Saskatchewan revealed that all lentil tissues, i.e. leaves, stems, pods and flowers, can be infected by spores of sclerotinia. Infection testing of whole plants at various ages showed that plants older than six weeks were significantly more susceptible. This decrease in resistance, combined with wet weather late in the growing season, may explain why sclerotinia is more of a problem in maturing lentil crops.

Stemphylium blight has been identified in a number of lentil fields in Saskatchewan. The foliar disease has similar leaflet drop symptoms as anthracnose, and lesions on leaves like ascochyta blight. It has not yet been confirmed as causing significant yield

losses, because the disease tends to show up later in the summer. The fungus thrives under warm (28°C), wet conditions. There have been differences noted between lentil varieties regarding their susceptibility to stemphylium blight.

For more information on fungicides, consult the product labels or the SAF publication, *Guide to Crop Protection*. For assistance in identifying plant diseases of lentil, consider utilizing the services of the SAF Crop Protection Laboratory at 306-787-8130.

Insect Control

Grasshoppers generally do not favour lentil foliage; however they do eat flower buds, flowers, and developing pods. Damage from grasshopper feeding is variable. Slight damage to the pods may result in shattering and seed loss. When the edge of the pod is chewed, the seeds are more susceptible to disease and staining. Research indicates that two grasshoppers per m^2 will reduce yields enough to warrant an insecticide application. MATADOR 120EC, DECIS, Malathion, and chlorpyrifos (LORSBAN, PYRINEX, NUFOS) are registered for control of grasshoppers in lentil. The highest rate of control will be achieved when grasshoppers are young. It is critical to respect the pre-harvest interval (PHI) of the insecticide selected to maintain crop marketability. For more information on grasshopper damage of lentil, see the SAF factsheet *Grasshoppers in Your Lentil Crops*, on the SAF website.

Cutworms may cause sufficient damage to newly-emerged lentil crops to require insecticide application. POUNCE is registered for control of red-backed cutworm, LORSBAN is registered for control of pale western cutworm and MATADOR 120EC and DECIS are registered for control of most species of cutworm in lentil.

The lygus bug is a pest of lentil in the United States, but has not been a problem in lentil in Saskatchewan to date. MATADOR 120EC is registered on lentil for the control of lygus bug, pea aphid, and potato leafhopper. The SAF publication, *Guide to Crop Protection*, provides more information about insecticides and insect monitoring.

Desiccation

A desiccant used to burn off crop foliage and weeds can reduce the time from maturity to harvest and reduce some harvesting problems. REGLONE DESICCANT is registered for use on lentil. REGLONE DESICCANT does not speed maturity of the crop, so treatment is made at the same time that swathing would occur. It should be applied when approximately 30 per cent of the lower-most pods are tan coloured, and their seeds rattle when shaken.

LIBERTY is registered for use on lentil and should be applied when 40-60 per cent of the pods have turned from yellow to brown. The pre-harvest interval for LIBERTY is nine days, and it should not be applied on crops being used for planting seed. Glyphosate is not a desiccant, but a pre-harvest application of glyphosate is registered in lentil for control of perennial weeds. It may provide some dry-down effect if weather conditions are warm and dry, and will kill the weeds over time. Do not apply glyphosate to crops to be used for planting seed, because it may cause uneven germination and abnormal seedling development. For more information on desiccants and pre-harvest weed control, consult the product label or the SAF publication, *Guide to Crop Protection*.

Harvesting

The average yield of lentil in Saskatchewan is approximately 1,180 kg/ha (1,050 lb./ac.). Pick-up reels, lifter guards, floating or flexible headers, and air reels can be added to harvest equipment to ease the handling of short-stature, tangled, or lodged lentil. Fields that were land rolled are easier to harvest, as the swather or combine cutterbar must be operated very close to the ground. A slower ground speed may also be required when harvesting lentil, compared to cereal crops.

Many lentil varieties have an indeterminate growth habit, and continue producing new flowers and pods until stopped by stress due to heat, drought, or low available nitrogen. Swathing should occur when about 30 per cent of the lowermost pods turn tan, and their seeds rattle. Shattering may be reduced by swathing under conditions of higher humidity. Lentil swaths are prone to wind damage.

Lentil can also be straight cut using a combine equipped with a flex header, or with a pick-up reel and vine lifters when seeds and pods are fully mature, or after desiccation. Excessively dry seed will chip and peel during threshing. It is preferable to thresh at about 18 per cent moisture and use aeration to dry the sample to 14 per cent for green varieties and 13 per cent for red varieties for safe storage. The red lentil splitting industry prefers product with a moisture content below 13 percent, to improve the efficiency in their splitting plant. Check with your red lentil buyer for any seed moisture content requirements.

Low cylinder or rotor speeds are required to reduce seed chipping and breaking during combining. Cylinder speeds of 250 to 500 RPM are normally used, depending on cylinder diameter and moisture content of the lentil seeds. Combine augers and grain augers should be operated at low speeds to reduce seed damage.

Storage and Handling

Lentil seed containing green weed seeds and other high moisture materials should be cleaned as soon as possible to prevent heating. Moisture levels up to about 13-14 per cent and temperatures below 15°C are considered safe for lentil. The use of aeration fans to reduce moisture and temperature will improve storage. If supplemental heat drying is necessary, air temperatures should not exceed 45°C to preserve germination, and the sample should not be dried more than 4 to 5 percentage points per pass through the dryer.

Lentil varieties with green seed coats will discolour with age, thus reducing the grade. Producers should store lentil in dry, dark conditions. Seed from successive years should not be mixed, as the oldest seed will cause a downgrading of the entire sample. Lentil should not be stored through a second summer season in order to avoid excessive discolouration and downgrading. Lentil seed is susceptible to increased chipping and peeling if handled in temperatures colder than -20°C. For more information on storing, handling and grading of lentil, consult the Saskatchewan Pulse Growers *Pulse Production Manual* (see Additional Information).

Marketing

A list of lentil buyers and marketers is available in the SAF publication - *Saskatchewan Special Crop Marketing Company Synopsis*. Several marketing companies offer production contracts for lentil.

Economics of Production

The SAF publication, *Crop Planning Guide - Specialty Crops*, includes information on projected costs of production and expected returns of green and red lentil in Saskatchewan.

Additional Information

Saskatchewan Agriculture & Food
- Ag Knowledge Centre – 1 866-457-2377
- Specialty Crop Report
- Guide to Crop Protection
- Ascochyta Blight in Pulse Crops
- Varieties of Grain Crops
- Inoculation of Pulse Crops
- Saskatchewan Special Crop Marketing Company Synopsis
- Crop Planning Guide - Specialty Crops
- Securing Low Erosion Risks after Growing Pulses and Oilseeds
- Soil Improvement with Legumes
- Sulphur Fertilization in Crop Production
- Guidelines for Safe Rates of Fertilizer Applied with the Seed

Saskatchewan Pulse Growers
- Pulse Production Manual - Website: www.saskpulse.com

Prairie Agricultural Machinery Institute
- Moisturizing Pulses to Reduce Damage (800) 567-7264

Alberta Agriculture, Food and Rural Development
- Land Rolling Guidelines for Pulse Crops in Western Canada
- Website: www.agric.gov.ab.ca

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